

Health, Safety and Ergonomically Risk Assessment of Mechanics using Job Safety Analysis (JSA) Technique in an Iran City

Yahya Rasoulzadeh¹, Seyed Shamseddin Alizadeh^{1*}, Saber Valizadeh²,
Hamidreza Fakharian³ and Sakineh Varmazyar⁴

¹Department of Occupational Health Engineering, Tabriz University of Medical Sciences, Tabriz, Iran;
ss.alizadeh2013@gmail.com, rasoulzadehy@yahoo.com

²Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran; saber.vlz@gmail.com

³Department of Occupational Health Engineering, Health Department of Tehran University of Medical Sciences,
Tehran, Iran; Fakharian.HSE@Gmail.com

⁴Department of Occupational Health Engineering, Qazvin University of Medical Sciences, Qazvin, Iran;
sepidehvar2005@yahoo.com

Abstract

Backgrounds: Automobile and automotive industries in developed and developing countries are important. There are many harmful factors in mechanics workplaces such as chemical and physical agents, ergonomics factors, mechanical and biological factors. **Objectives:** This study aimed to identify safety, health and ergonomically hazards and recommend the control measures in the automotive repair shops in Tekab city in Iran. **Methods:** Sixty-three car repair shops in the Tekab city were identified. The researchers with the participation of employees broke any of jobs into their constituent tasks and steps. Then the researchers identified each step hazards and calculated related risks. Finally based on the risk assessment and risk priorities, the control measures were recommended. **Findings:** Nine jobs were identified. Inhalation of acid and soldering mist vapor and contact with unsafe equipment is the most important accident in the battery repairing and lathing job respectively. Fire caused by thinner, gasoline, paint and resin, severe trauma to the hands and feet, and contact with welding flame is the most important accident in the painting, car smooth working and repairing radiator job respectively. Fire caused by gasoline and motor oil is the most important accident in the oil changes and tire change and mechanical technician jobs. Falling car on person is the most important accident in the front part of car repair and absorbers and exhaust repair jobs. **Application/Improvements:** Job safety analysis is a useful method for identifying hazards at vehicle mechanics job. Using this method can identify hazards and finally recommends appropriate control measures.

Keywords: Accident, Automotive Industries, Control Measures, Hazard

1. Introduction

Industrialization process has led to the increasing use of technical tools and machinery. Due to failure to comply with the proper principles of the construction or use of these devices, work accidents increased. On one hand, the use of mechanical and electrical driving force turned the manual activities to machine works; and on the other hand, the division of work, increased production and

speed of the work. As a result of this, the risk is increased in industrial environments^{1,2}. Occupational accidents have a negative impact on economic indicators and cause workers injury. Despite all efforts, although the evaluation of all aspects of the human costs such as suffering and grief of victims and their relatives, it is impossible to come, but some of the cost dimensions are measurable. Costs of unsafe conditions and workforce pain are not easily tangible but its value in the Gross National Income

*Author for correspondence

is calculable¹. Automotive and automotive industries in developed and developing countries are important. Many experts are associated with this industry. Mechanics is one of them. Automobile mechanic is a person who repairs and overhauls cars and other automotive vehicles, or their systems and parts. He/she examines them, makes necessary repairs, emplacements, adjustments, and presents the repaired vehicle to his/her superior or to the customer³. Auto mechanics work in environments that have high probability of risk in it. There are many harmful factors in Mechanics workplaces such as chemical and physical agents, ergonomics factors, mechanical and biological factors⁴. Prank and et al. in two studies surveyed the levels of isocyanate compounds in car repair workshops and industrial painting companies^{5,6}. In this study was concluded that the risk of exposure to painting particles during painting process is significant. Also it was determined that the main rout of exposure is skin. Delgado and et al examined the potential exposure of skin with non-volatile compounds in painting process in car repair workshops^{7,8}.

Risk assessment is a reasonable method to determine the qualitative and quantitative risks and evaluate the potential consequences arising from possible accidents to people, materials, equipment and environment. In fact, the effectiveness of the existing control methods is specified and the valuable data for decision-making on risk reduction, improve and control systems are provided⁹⁻¹⁵. In this method, every step of the job is carefully checked, potential risks of each step are identified and assessed, and the best solution to eliminate or reduce hazards is recommended¹⁶. JSA is a systematic study to identify and assess existing or potential risks in any process or job¹⁷. In this method the job is broken to steps, then hazards

are identified in all steps and finally the risk number is estimated for each hazard and control measure are recommended. This method is also known as Task Hazard Analysis (THA), Safe Job Analysis (SJA) and Job Hazard Analysis (JHA)¹⁸. In the world many studies have been done to reduce accidents in different fields that each of them leads to reduce accidents with some interventions. Given that very few studies have been conducted to assess the risks in Auto mechanic and hardly can find a comprehensive study in this area, this study aimed to identify hazards and assess risks in the automotive repair shops in Tekab city (a city with more than 44,000 people in the North West of Iran).

2. Methods and Materials

2.1 The Study Population

This study was a descriptive study that aims to identify safety, health and ergonomically hazards and recommend the control measures in the automotive repair shops in Tekab city. The study population was all staff of the automotive repair shops in Tekab city. Accordingly, 63 car repair shops in the Tekab city were identified whom were the all car parts repairman. The general characteristics of these people are shown in Table 1. To accomplish this study, after coordination, the researchers went to the workshops. They observed the activities in detail and after interviews with staff, information relating to any part of the job were recorded in the form of JSA (Figure 1).

2.2 Job Safety Analysis Process

Job Safety Analysis Process includes below steps^{16,19}:

Job Safety Analysis (JSA) form										
Job title:		Work-hours: day		week		Work condition: routine		nonroutine		
Assessment team memebers:										
Job description:										
Task	Step	Hazard	Incident	Cause	Consequence	Probability	Severity	Risk number	Risk level	Required action

Figure 1. A sample of Job Safety Analysis (JSA) form.

Table 1. General characteristics of automotive repairmans

No.	Job	The average age of each group	Average work experience in each group	Education (Majority)	Marital status (majority)	Working hours per week
1	Mechanical technician	35.3	13.8	Guidance school	Married	65.6
2	Oil changes and tire change	31.2	12.1	Secondary school	Married	67.6
3	Repairing radiator	23	8	Guidance school	Single	60
4	Battery repair	31.8	12	Guidance school	Married	68
5	Car smooth working	34.3	13.6	Diploma	Married	66.3
6	Painting	35.3	15.5	Guidance school	Married	64.8
7	The front part of car repair	28	10	Guidance school	Married	65
8	Lathing	40.3	22	Guidance school	Married	66
9	Absorbers and exhaust repair	34.6	16	Guidance school	Married	67.3

Table 2. Accident severity classification

Description	Class	Hazard type
Death or disappearance of the entire system	1	Catastrophic
Severe injuries, illnesses and damage to the system	2	Critical
Small injuries, illnesses and damage to the system	3	Marginal
Very small injuries, illnesses and damage to the system	4	Inconsiderable

Table 3. Accident occurrence probability criteria

Description	Hazard level	Occurrence probability
Frequently occurs	A	$X > 10^{-1}$
Several times occurs during the life of the system	B	$10^{-2} < X < 10^{-1}$
Occasionally occurs during the lifetime of the system	C	$10^{-3} < X < 10^{-2}$
Its Occurrence probability is very low during the lifetime of the system	D	$10^{-4} < X < 10^{-3}$
Its occurrence probability in the life of the system is minimal	E	$X < 10^{-4}$

Table 4. Decision making criteria based on risk levels

Risk classification	Risk criteria
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable
1D, 2C, 2D, 3B, 3C	Undesirable
1E, 2E, 3D, 3E, 4A, 4B	Acceptable but needs reconsideration
4C, 4D, 4E	Undesirable

2.2.1 Breaking the Job

First the jobs in car repair shops were found. Accordingly nine jobs were identified (Table 1). The researchers with the participation of employees broke any of these jobs into

their constituent tasks. Then all steps of each task listed. The observations and interviews results were recorded in JSA form. To ensure a correct list of tasks and steps is provided, the completed form for each job was reviewed with staff again.

2.2.2 Hazard Identification

In this step the researchers identified each step hazards using a pre-prepared checklist¹⁸, activities observing and interviewing with the repairman, then recorded identified hazards in JSA form.

2.2.3 Risk Assessment

To calculate risks, the following factors were identified and using equation 1 each accidents risk estimated:

Accident Occurrence Probability (P)

Accident Consequence Severity (S)

Equation 1 Risk = P*S

Information related to the above two factors were obtained based on interviews; review of accidents records, Mechanics experience and observation their activities. In all of these steps, the assessment tool was a set of structured questionnaires. To calculate the probability of occurrence, consequences severity and decision-making based on the level of calculated risk, Tables 1-4. were used respectively¹⁶.

2.2.4 Control Measures

Based on the risk assessment and risk priorities, the control measures were recommended. According to risk priority can insure that effective control measure are provided and implemented.

3. Results

Tables 5-7. show the results of this study. As can see in Table 5, the mechanical technician has two hazards with “unacceptable” risk level. In this job, there are 6 hazards with “undesirable” risk level, 4 hazards with “acceptable but needs reconsideration” risk level and one hazard with “inconsiderable” risk level. Fire caused by gasoline and motor oil is the most important accident in this job. The battery repairing job has one hazard with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level, one hazard with “acceptable but needs reconsideration” risk level and one hazard with “inconsiderable” risk level. Inhalation of acid and soldering mist vapor is the most important accident in this job. The lathing job has 2 hazards with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level. Contact with unsafe equipment is the most important accident in this job. According to Table 6, the painting

job has 4 hazards with “unacceptable” risk level. In this job, there are 4 hazards with “undesirable” risk level. Fire caused by thinner, gasoline, paint and resin is the most important accident in this job. The car smooth working job has 7 hazards with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level, one hazard with “acceptable but needs reconsideration” risk level. Severe trauma to the hands and feet is the most important accident in this job. The absorbers and exhaust repair job has 5 hazards with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level. Falling car on person is the most important accident in this job. According to Table 7, the repairing radiator job has 2 hazards with “unacceptable” risk level. In this job, there are 7 hazards with “undesirable” risk level. Contact with welding flame is the most important accident in this job. The oil changes and tire change job has 5 hazards with “unacceptable” risk level. In this job, there are 7 hazards with “undesirable” risk level, 4 hazards with “acceptable but needs reconsideration” risk level. Fire caused by gasoline, motor oil and other petroleum products is the most important accident in this job. The front part of car repair job has one hazard with “unacceptable” risk level. In this job, there are 8 hazards with “undesirable” risk level. Falling car on person is the most important accident in this job.

4. Discussion

The main incident in the mechanical technician job is fire. In this job, given that a lot of gasoline and motor oil poured on the floor of the shop, the probability of fire is high. Also in these workplaces, the housekeeping principles do not followed by workers, as a result the splurge on the floor is high. Heat sources that may be exposed to gasoline and motor oil and caused the fire are smoking, heater, sparks from the car starters and etc. The only incident with unacceptable risk in battery repairing job is inhalation of acid and soldering mist vapors that could eventually lead to respiratory and other diseases. On the one hand, due to the nature of the job, use of acid and soldering is inevitable. On the other hand, usually due to a lack of monitoring, workers don't use personal protective equipment, local ventilation or other control measures. As a result, risk of exposure to these harmful agents is very high. In lathing job, due to use of rotating and moving equipment the risk of contact with the equipment is unac-

Table 5. Hazards, risks and required actions for mechanical technician, battery repairing and lathing jobs

Job	Hazard	Incident	Consequence	Risk number	Risk level	Required action
Mechanical technician	Gasoline and Motor Oil	Fire	Burning	2A	Unacceptable	- Spill prevention - Training - Provide the fire extinguishers
	Car Falling risk	Falling car on person	Death, injury and fracture	2B	Unacceptable	- Use the proper jacks - Training - Use of an auxiliary base
	Moving parts of the vehicle	Hand caught in moving parts	Injury and amputation	3B	Undesirable	- Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment
	Slippery workplace	Slipping and falling	Injury and fracture	3B	Undesirable	- Use of appropriate shoes - Clean the workplace floor continuously - Use of appropriate protective masks
	Vapors of gasoline and motor oil	Inhalation of vapors of gasoline and motor oil	Respiratory diseases and other diseases	3B	Undesirable	
	Press machine	Hand caught in press machine	Injury, amputation and fracture	3B	Undesirable	- Use the Interlock Devices - training
	Lubritorium	Falling into a pit of Service	Bone fracture and Head injuries	3B	Undesirable	- Use the shield and cover the hole of Service
	Lighting	Exposure with inadequate lighting	Vision loss	3B	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Unsuitable workplace	Akward posture	Musculoskeletal Disorders	4B	Acceptable but needs reconsideration	- Redesign workstations
	Hot parts of the vehicle	Contact with hot parts of the vehicle	Burning	4B	Acceptable but needs reconsideration	- Use of personal protective equipment
	Improper tools layout	Individual collisions with variety of tools	Injury	4B	Acceptable but needs reconsideration	- Use of tools - Putting the tools in appropriate place
	Noise	Noise exposure	Hearing loss	4B	Acceptable but needs reconsideration	- Training - Use of personal protective equipment
	Vibration	Vibration exposure	Physical disorders	4C	Inconsiderable	- Training - Use of appropriate equipment - Use of personal protective equipment
	Acid and soldering mist vapor	Inhalation of vapors	Respiratory diseases and other diseases	2A	Unacceptable	- Use of appropriate protective masks and goggles - Training
Battery repairing	Exist various acids	Battery explosion and throwing acid	Burning	3B	Undesirable	- Use of personal protective equipment - Training
	Acid spilling	Contact	Burning	3B	Undesirable	- Acid storage in safe locations - Acid transport with full caution
	Lack of warning signs	Lack of knowledge and accident occurrence	Injury	3B	Undesirable	- Provide warning signs - Training
	Improper ventilation	Exposure to heat and acid vapors	Heat stress and other diseases	3B	Undesirable	- Ventilation system design - Use of personal protective equipment
	Lighting	Exposure with inadequate lighting	Vision loss	3B	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Improper workplace layout	Individual collisions with variety of tools	Injury and low efficiency	4B	Acceptable but needs reconsideration	- Putting the tools in appropriate place - Training
	Unsafe equipment	Electrocution	Injury	1C	Inconsiderable	- Providing safety equipment - Training

Lathing	Unsafe equipment	Contact with Unsafe equipment	Amputation and injury	2A	Unacceptable	- Providing safety equipment - Training
	Moving parts of machines	Hand and clothes caught in moving parts	Amputation and injury	3A	Unacceptable	- Use the Interlock Devices - training
	Noise	Noise exposure	Hearing loss	1D	Undesirable	- Use of personal protective equipment - Training
	Metal filings	Entry the metal filings in the eyes	Damage to eyes	1D	Undesirable	- Use of gaurds on equipment - Use of personal protective equipment
	Heavy parts	Lifting and handling heavy parts	Musculoskeletal disorders	1D	Undesirable	- Use of mechanical handling equipment - Training
	Horsepaly	Caught clothing and hands between and inside equipment	Amputation and injury	2C	Undesirable	- Training - Monitoring
	Waste on the floor	Entering sharp objects in feet	Feet injury	3C	Undesirable	- Use of personal protective equipment - Housekeeping

Table 6. Hazards, risks and required actions for painting, car smooth working and absorbers and exhaust repair jobs

Job	Hazard	Incident	Consequence	Risk number	Risk level	Required action
Painting	Thinner, gasoline, paint and resin	Fire	Property damage	1C	Unacceptable	- Training - Install safety labels - Isolation solvent from the fire source
	Paints and chemical solvents	Exposure to paints and chemical solvents vapours	Skin and respiratory diseases	2B	Unacceptable	- Use of personal protective equipment - Training
	Aerosol	Exposure to aerosol	Respiratory diseases	2B	Unacceptable	- Use of personal protective equipment
	Lubritorium	Falling into the pit of Service	Bone frature and head trauma	3A	Unacceptable	- Use the shield and cover the hole of service
	Lighting	Exposuire with inadequate lighting	Vision loss	1D	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Inappropriate standing	Inappropriate posture at work	Musculoskeletal disorders	3C	Undesirable	- Redesign workstation
	Noise	Noise exposure	Hearing loss	3C	Undesirable	- Use of personal protective equipment - Training - Air compressor isolation
	Splurge the materials and tools on the floor	Contact with materials and tools	Body injury	3C	Undesirable	- Housekeeping - Training

Car smooth working	Smooth out the crumpled metal	Severe trauma to the hands and feet	hands and feet fracture	2B	Unacceptable	- Use of personal protective equipment - Use of appropriate tools
	Noise	Noise exposure	Hearing loss	2B	Unacceptable	- Use of personal protective equipment - Training
	Fume	Inhalation of fumes	Respiratory diseases and other diseases	2B	Unacceptable	- Use of appropriate protective masks
	Sharp pieces of objects	Hands encounter with sharp metal pieces	Hands injury	3A	Unacceptable	- Use of personal protective equipment - Use of appropriate tools
	Welding torch	Contact the body with flame	Burning	3A	Unacceptable	- Use of personal protective equipment - Training
	Lubritorium	Falling into the pit of Service	Bone fracture and head trauma	3A	Unacceptable	- Use the shield and cover the hole of service
	Welding	Look up the pieces when welding	Eyes injury	3A	Unacceptable	- Use the welding glasses - Training
	Metal filings	Entry the metal filings in the eyes	Damage to eyes	1D	Undesirable	- Use of personal protective equipment
	Lighting	Exposure with inadequate lighting	Vision loss	1D	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Inappropriate standing	Inappropriate posture at work	Musculoskeletal disorders	3C	Undesirable	- Redesign workstation
	Unsafe equipment	Electrocution	Death and injury	3C	Undesirable	- Providing safety equipment - Training
	Hot metals	Contact with hot surfaces	Burning	3C	Undesirable	- Use of personal protective equipment
	Heat	Heat exposure	Heat stress	1E	Acceptable but needs reconsideration	- Ventilation system redesign
Absorbers and exhaust repair	Car Falling risk	Falling car on person	Death, injury and fracture	1C	Unacceptable	- Use the proper jacks - Training - Use of an auxiliary base
	Metal vapours	Inhalation of metal vapours	Respiratory diseases and other diseases	2B	Unacceptable	- Use of appropriate protective masks
	Working with electric sanding machine.	Contact with the body	Amputation and hand injury	3A	Unacceptable	- Training - Use of protection devices
	Shock ventilation system	Caught hands between and inside equipment	Amputation and injury	3A	Unacceptable	- Use the Interlock Devices - Training - Use of protection devices
	Lubritorium	Falling into the pit of Service	Bone fracture and head trauma	3A	Unacceptable	- Use the shield and cover the hole of service
	Metal filings	Entry the metal filings in the eyes	Damage to eyes	1D	Undesirable	- Use of personal protective equipment
	Explosion risk	Explosion	Death, injury and amputation	2C	Undesirable	- Keep cylinders away from fire source
	Splurge the materials and tools on the floor	Contact with materials and tools	Body injury	3C	Undesirable	- Housekeeping - Training
	Unsuitable workplace	Akward posture	Musculoskeletal Disorders	3C	Undesirable	- Redesign workstations
	Hot parts of the vehicle	Contact with hot parts of the vehicle	Burning	3C	Undesirable	- Use of personal protective equipment - Use of tools

Table 7. Hazards, risks and required actions for repairing radiator, oil changes and tire change and the front part of car repair jobs

Job	Hazard	Incident	Consequence	Risk number	Risk level	Required action
Repairing radiator	Welding flame	Contact with the body	Burning	3A	Unacceptable	- Use of personal protective equipment - Training
	Hot water	Throw hot water on the face and body	Face and body burning	3A	Unacceptable	- Training - Check the radiator when is cooling
	Radiator falling risk	Falling the Radiator on feet	Feet injury	1D	Undesirable	- Use safety shoes. - Training
	Lighting	Exposure with inadequate lighting	Vision loss	1D	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Metal filings	Entry the metal filings in the eyes	Damage to eyes	1D	Undesirable	- Use of personal protective equipment
	Slippery workplace	Slipping and falling	Injury and fracture	3C	Undesirable	- Use of appropriate shoes - Clean the workplace floor continuously
	Splurge the materials and tools on the floor	Contact with materials and tools	Body injury	3C	Undesirable	- Housekeeping - Training
	Radiator hot parts	Contact with hot parts of the radiator	Burning	3C	Undesirable	- Use safety gloves
	Heavy radiators	Improper handling of the heavy radiators	Musculoskeletal Disorders	3C	Undesirable	- Use the proper equipment to carry heavy radiators - Training
	Motor oil, gasoline and other petroleum products	Fire	Burning and financial costs	1B	Unacceptable	- Separation of combustible materials from fire sources - Training - Use of warning signs - Provide extinguisher
	Car Falling risk	Falling car on person	Death, injury and fracture	1C	Unacceptable	- Use the proper jacks - Training - Use of an auxiliary base
	Gasoline and motor oil vapors	Inhalation of vapors of gasoline and motor oil	Respiratory diseases and other diseases	2B	Unacceptable	- Use of appropriate protective masks
	Slippery workplace	Slipping and falling	Injury and fracture	3A	Unacceptable	- Use of appropriate shoes - Clean the workplace floor continuously
	Hot motor oil	Splash hot oil on the person	Burning	3A	Unacceptable	- Use of appropriate equipment - Use of appropriate protective gloves
	Moving parts of the vehicle	Hand caught in moving parts	Injury and amputation	1D	Undesirable	- Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment
	Lubritorium	Falling into the pit of Service	Bone fracture and head trauma	1D	Undesirable	- Use the shield and cover the hole of service

Oil changes and tire change	Lighting	Exposure with inadequate lighting	Vision loss	1D	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Lubritorium with insufficient space	Akward posture	Musculoskeletal Disorders	1D	Undesirable	- Redesign lubritorium
	Heavy tires	Improper handling of tires	Musculoskeletal Disorders	3C	Undesirable	- Use the proper equipment to carry heavy tires - Training
	Aerosol	Exposure to aerosol	Respiratory diseases	3C	Undesirable	- Use of personal protective equipment
	Hammer of batting	Heavy hitting the legs	Bruises and bone fracture in the foot	3C	Undesirable	- Use of appropriate equipment - Use of appropriate shoes
	Motor oil, gasoline and other petroleum products	Dermal contact	Deramal disease	1E	Acceptable but needs reconsideration	- Use of personal protective equipment
	The sudden movement of the vehicle	Collision the car with person	Bone fracture and injury	1E	Acceptable but needs reconsideration	- Warn when the car is turning on - Ensure that the vehicle is not in gear.
	Metal parts under the car	Collision the head with them	Head injuries	1E	Acceptable but needs reconsideration	- Construct lubritorium with appropriate height - The use of helmets in lubritorium
	Noise	Noise exposure	Hearing loss	1E	Acceptable but needs reconsideration	- Use of personal protective equipment - Training - Air compressor isolation
The front part of car repair	Car Falling risk	Falling car on person	Death, injury and fracture	1C	Unacceptable	- Use the proper jacks - Training - Use of an auxiliary base
	Unsuitable workplace	Akward posture	Musculoskeletal Disorders	2B	Undesirable	- Redesign workstations
	Moving parts of the vehicle	Hand caught in moving parts	Injury and amputation	1D	Undesirable	- Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment
	Lubritorium	Falling into the pit of Service	Bone fracture and head trauma	1D	Undesirable	- Use the shield and cover the hole of service
	Lighting	Exposure with inadequate lighting	Vision loss	2C	Undesirable	- Redesign Lighting - Paint and clean the workplace walls
	Unsafe equipment	Electrocution	Injury	2C	Undesirable	- Providing safety equipment - Training
	Horsepaly	Caught clothing and hands between and inside equipment	Amputation and injury	2D	Undesirable	- Monitoring
	Hot parts of the vehicle	Contact with hot parts of the vehicle	Burning	3C	Undesirable	- Use of personal protective equipment - Use of tools
	Noise	Noise exposure	Hearing loss	3C	Undesirable	- Use of personal protective equipment - Air compressor isolation

ceptable. The occurrence of this incident can be severe and even can lead to amputation of the affected person. In this job, workers have not received adequate training in the field of occupational health and safety and they do not use personal protective equipment. Also the safety of available equipment is not acceptable. As a result, the activities of workers have high risk of contact with unsafe equipment. In painting job, the main materials used are thinner, gasoline, paint and resin. As can see in Table 7, fires and exposure to these substances have the unacceptable risk level. Several reasons can lead to increase the risk of these incidents such as: the high volume of these substances in the workplace, much use of these materials, don't use of personal protective equipment, lack of monitoring and insufficient training. In car smooth working job, severe trauma to the hands and feet due to smooth out the crumpled metal has a high risk and can lead to fractures of the hands and feet. The main reasons for this incident can be worker negligence, lack of proper tools, don't using of personal protective equipment and inadequate training. In the absorbers and exhaust repair job, there is the probability of worker death. In this job, the falling car on person due to improper use of the lift jacks and insufficient training can occur. The risk of this incident is unacceptable because the severity of its consequences is very high and if the person If the person does not die as a result of this incident, he/she would suffer from severe damage and broken bones. In the repairing radiator, the presence of welding flame in contact with the body can burn him. The reason of unacceptable risk of this incident is that the person has high exposure to welding flame. Based on the observations, workers in this job don't use the personal protective equipment and don't have any training course about safety and health. As a result, the probability of this incident is high for these workers. In the oil changes and tire change job, workers use petroleum materials such as motor oil and gasoline during shift work. Due to lack of housekeeping, low education level of workers and lack of monitoring; splurge occurs in this job. When heat sources such as smoking, heater and spark exposed to these substances on the floor, fire will occur. The consequences of these fires can be severe burns and high financial costs. In the front part of car repair there is the death possibility due to of falling car on person. If the person does not use the appropriate jacks or his training is not enough, this incident can occur. The consequences of this incident are very severe such as severe injuries, fracture or death.

5. Conclusion

Job Safety Analysis (JSA) is a useful method for identifying hazards at various jobs including vehicle mechanics. As shown in the results, this method can identify hazards, incident causes and incident consequences and finally recommends appropriate control measures. Also it is possible using results of this study, determining the training needs of automotive mechanics and writing a health and safety operation procedure for automotive mechanics. Generally to improve health and safety conditions of automotive workshops, the following suggestions are offered:

- Continues monitoring of occupational health and safety in automotive workshops;
- Writing a health and safety operation procedure for automotive mechanics;
- Providing safe equipment;
- Providing personal protective equipment and using them;
- Redesigning the work station based on ergonomically rules;
- Implementation of recommended technical-engineering measures in this study.

6. References

1. Ali M, Ranjvar MAM. Effective factors role in occupational accidents according safe design and implementation approach. Power and Energy Ministry; 2010.
2. Sundaram BR, Vasudevan SK, Aravind E, Karthick G, Harithaa S. Smart car design using RFID. Indian Journal of Science and Technology. 2015 Jun; 8(11):61511.
3. ILO. International hazard datasheets on occupation, mechanic, automobile. 2000.
4. ABe. Requirements, instructions and guidelines. Occupational and environmental center: Medical Sciences University, Environmental Research Center; 2012.
5. Pronk A, Tieleman E, Skarping G, Bobeldijk I, Van Hemmen J, Heederik D. Inhalation exposure to isocyanates of car body repair shop workers and industrial spray painters. *Annals of Occupational Hygiene*. 2006; 50(1):1–14.
6. Pronk A, Yu F, Vlaanderen J, Tieleman E, Preller L, Bobeldijk I, et al. Dermal, inhalation, and internal exposure to 1, 6-HDI and its oligomers in car body repair shop workers and industrial spray painters. *Occupational and Environmental Medicine*. 2006; 63(9):624–31.

7. Delgado P, Porcel J, Abril I, Torres N, Terán A, Zugasti A. Potential dermal exposure during the painting process in car body repair shops. *Annals of Occupational Hygiene*. 2004; 48(3):229–36.
8. Shamseddin S, Alizadeh YR, Valizadeh S, Parisa Moshashaie. Safety and health instruction in mechanics provided using job safety analysis technique. *Scientific Journal of Pure and Applied Sciences*. 2015; 4(2):44–8.
9. ISO/IEC. Technical report: ISO/IEC TR 1998:3-13335(e) information technology — guidelines for the management of it security -part 3: techniques for the management of it security. 1998.
10. Alizadeh SS, Rasoulzadeh Y, Moshashaie P, Varmazyar S. Failure Modes and Effects Analysis (FMEA) Technique: A Literature Review. *Scientific Journal of Review*. 2015; 4(1):1–6.
11. Alizadeh SSh, Mortazavi SB, Sepehri MM. Analysis of Iranian construction sector occupational accidents (2007-2011). *Scientific Journal of Review*. 2013; 2(7):188–93.
12. Ketabi D, Barkhordari A, Mirmohammadi SJ, Mehrparvar AH. Aberrant behaviors and road accidents among Iranian truck drivers, 2010. *Health promotion perspectives*. 2011; 1(2):130–6.
13. Rasoulzadeh Y, Gholamnia R. Effectiveness of an ergonomics training program on decreasing work-related musculoskeletal disorders risk among video display terminals users. *Health promotion perspectives*. 2012; 2(1):89–91.
14. Roushan AS, Alizadeh SS. Estimation of economic costs of accidents at work in Iran: A case study of occupational accidents in 2012. *Iran Occupational Health Journal*. 2015; 12(1):12–9.
15. Taklif A, Shokouhian R, Arasteh AS, Dalfard VM. Quantifying risk analysis using database in industrial investment projects by Topsis method. *Indian Journal of Science and Technology*. 2011; 4(7):779–84.
16. Parvin N, Sh Alizadeh S, Farideh G, Shahtaheri S. Hazards identification and assessment in a production factory using Job Safety Analysis (JSA). *Journal of Environmental Science and Technology*. 2007; 8(4).
17. Occupational Safety and Health Bureau. Job Safety Analysis. Identification of hazards. Montana: Department of Labor and Industry.
18. OSHA. Job hazard analysis, OSHA 3071, (Revised). 2002.
19. Rozenfeld O, Sacks R, Rosenfeld Y, Baum H. Construction Job Safety Analysis. *Safety Science*. 2010; 48(4):491–98.